

# DIHeDRAL: Downhole Regolith Interrogation with Helium-Assisted Drill and LIBS, Phase II

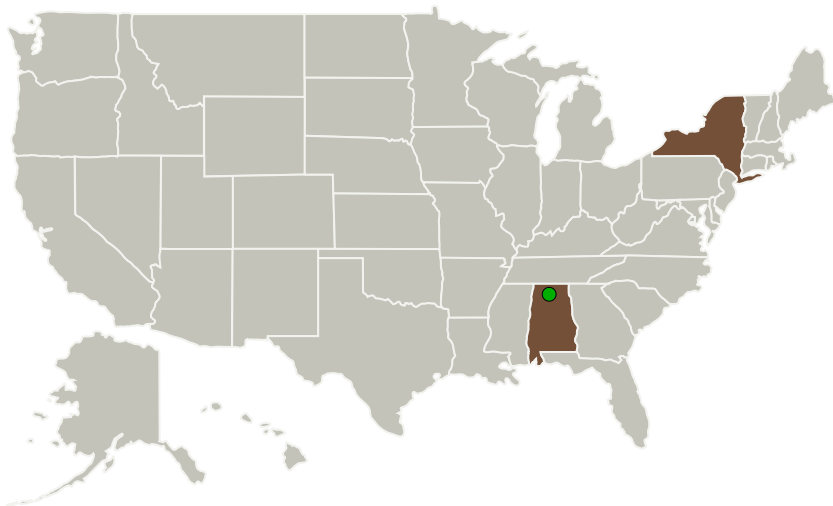
Completed Technology Project (2011 - 2013)



## Project Introduction

Future landed robotic missions to the lunar poles will seek to characterize the properties of subsurface regolith. Current instruments for such in-situ analysis, however, require that geological samples be brought to the surface by a sample acquisition tool and subsequently processed and presented to the analyzer. This model has significant limitations with regard to science yield: evaporation of volatile molecules before reaching the instrument, loss of stratigraphic information, sample bias, and cross-contamination. Furthermore, sophisticated sample acquisition, processing and handling mechanisms required to operate in uncontrolled, dusty environments are expensive and failure-prone. We therefore propose an alternative: bring the instrument to the sample. Specifically, we propose development of a fiber-coupled laser-induced breakdown spectrometer (LIBS) system, integrated into a 3m-class drill. LIBS uses a high-energy laser pulse to create a plasma on the surface of the material under test; the atomic emissions are collected by a spectrometer and yield elemental composition and basic molecular information. DIHeDRAL will allow profiling of an entire borehole wall, centimeter by centimeter, 360 degrees, from the top to the bottom. The proposed Phase II work will include development of a functional prototype and its integration in a drill string and test to a depth of 1m. The performance of the sensor will be tested in a chamber capable of closely reproducing the conditions of the Lunar surface.

## Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
Honeybee Robotics, Ltd.	Lead Organization	Industry	Pasadena, California
● Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	New York

## Project Transitions

**June 2011:** Project Start**November 2013:** Closed out

**Closeout Summary:** DIHeDRAL: Downhole Regolith Interrogation with Helium-Assisted Drill and LIBS, Phase II Project Image

**Closeout Documentation:**

- Final Summary Chart Image(<https://techport.nasa.gov/file/138807>)

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

Honeybee Robotics, Ltd.

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

**Principal Investigator:**

Kris Zacny

**Co-Investigator:**

Kris Zacny

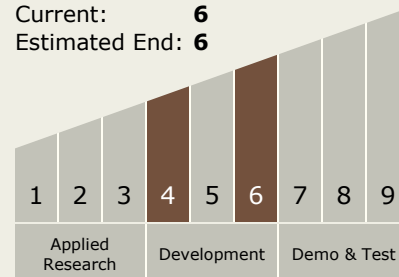
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## Technology Maturity (TRL)

Start: **4**  
Current: **6**  
Estimated End: **6**



## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - └ TX08.3 In-Situ Instruments and Sensors
    - └ TX08.3.3 Sample Handling

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System